S. P. I. No.	Name and Source	Number of Plants	Per Cent. Variegated.
25187	Italian alfalfa (Pisa)	36	16.6
24928	Provence alfalfa (Germany)	39	15.3
24723	Russian alfalfa (southern Russia)	46	15.2
24858	Italian alfalfa (Florence)	40	15.0
25181	Pfalzer Lucern (Bavarian Palatinate, Germany)	14	14.3
24732	Russian alfalfa (northern Russia)	46	13.0
24720	Provence alfalfa (Germany)	39	12.8
24729	Hungarian alfalfa (Austria)	44	12.7
23396	Commercial Sand Lucern (Darmstadt, Germany)	35	11.4
24731	Russian alfalfa (southern Russia)	45	11.1
25186	Algerian alfalfa (Setif, Algeria)	19	10.5
25180	Moravian alfalfa (Bohemia)	39	10.3
24724	Russian alfalfa (northern Russia)	41	9.7
24737	Commercial Sand Lucern (Bohemia)	41	9.7
24734	Provence alfalfa (Germany)	42	9.5
25185	Hungarian alfalfa (Austria)	13	7.7
25179	Hungarian alfalfa (Austria)	40	7.5
24725	Spanish alfalfa	33	6.0
25109	Austrian alfalfa (Vienna)	37	5.4
25168	Commercial Sand Lucern (Bohemia)	40	0
24736	Spanish alfalfa	36	0
24726	Turkestan alfalfa	43	0
24738	Turkestan alfalfa	42	0
24739	Turkestan alfalfa	43	0
	Average	37	24.1

Name	Number of Strains	Average Per Cent. of Variegation	Average Deviation
Turkestan alfalfa	3	0	0
Spanish alfalfa	2	3	3
Austrian alfalfa	1	5.4	0
Algerian alfalfa	1	10.5	0
Hungarian alfalfa	4	11.6	4.0
Russian alfalfa	5	13.3	2.4
Moravian alfalfa	2	16.8	6.5
Bohemian alfalfa	1	18.3	0
Italian alfalfa	4	22.8	7
Provence alfalfa	7	25.5	12
Palatine (Pfalzer) alfalfa	2	26.8	12.5
Roumanian alfalfa	2	27.7	8.3
Commercial Sand Lucern	15	27.7	12.4
German alfalfa	4	30.2	10.7
Old German Franconian alfalfa	10	38.9	8.9
Eifel alfalfa	1	54.0	0
Combined variegated forms (*i. e.*, omitting Turkestans)	61	25.3	

SOCIETIES AND ACADEMIES

THE GEOLOGICAL SOCIETY OF WASHINGTON

At the 234th meeting of the society, held on Wednesday, November 30, 1910, the following papers were read:

Regular Program

The Influence of Marine Currents on Deposition in Continental Seas: E. O. Ulrich.

This paper tends to prove that Mr. Bailey Willis's views in regard to non-deposition in continental seas as the result of current action are in the main unfounded. In brief, Mr. Willis's views are that the numerous minor hiatuses in the geologic column are commonly to be attributed to non-deposition and even to submarine scour, resulting from marine currents, rather than to emergence of the sea bottom. In preface brief allusions were made to instances of local thinning or absence of sediments that may be justly ascribed to current work. It is doubtless true that marine currents flow at certain times through sub-marginal troughs like the Lævis channel.

Arguments were brought against Willis's views under two headings, namely: the improbability of the existence in Paleozoic continental seas of currents competent to bring about such results; and the lack of evidence of such action having taken place under conditions obviously the most favorable for the existence of such currents.

Currents of sufficient intensity to cause an appreciable interruption of deposition over wide interior areas could only exist in great seas, in which the admittedly necessary "trans-continental currents" of Willis might be developed. Such seas have no foundation in fact. At any given time the Paleozoic seas of North America were far less extensive than those delineated by Willis or even those depicted in Schuchert's "Paleogeography of North America." Such maps are synthetic, giving the maximum development of several successive seas. The Black River—early Trenton submergence—having, as generally believed, the greatest areal development of any Paleozoic seas, may be taken as the extreme example. This submergence consisted of no less than five and possibly six distinct transgressions, as shown by the areal distribution of the successive faunas and of the beds containing them. These six faunas are sharply defined and any two juxtaposed faunas show clearly by the varying direction of the overlap of their containing formations that they invaded from quite different oceanic basins. Moreover, no two of these faunas

could have been synchronous, since there is no evidence of intermingling of species characterizing the respective formations in the median areas of interfingering overlaps.

It is only the pelagic and semi-pelagic types that can be depended upon for exact correlation between widely separated areas, and prove the existence of unobstructed current-highways. Referring to such organisms, the distribution of the Eopaleozoic graptolites offers very strong arguments against the hypothesis of transcontinental currents in the interior basins. The most important of the graptolite faunas are confined to current-swept submarginal channels. Had these currents continued across the continental border, as assumed by Willis, the graptolites must have been carried by them into and through the interior seas, a condition wholly negatived by the evidence in hand.

Perhaps the strongest argument against the efficiency of currents in preventing deposition in the interior continental seas is found in stratigraphic overlaps. In any period of sea-advance, beds are deposited by overlap toward the "positive" or relatively elevated areas. At the same time, the submergence increasingly favors the formation of currents. If currents were present and competent to cause scour, phenomena quite opposed to those observed would obtain. The lower beds, which are absent, should be present, and the later beds, formed in a sea supposedly favorable to the extensive development of strong currents, should not be deposited, or should show the effects of current action by diminished thickness.

Notes on Argentina: BAILEY WILLIS.

No abstract. EDSON S. BASTIN,
Secretary

THE GEOLOGICAL SOCIETY OF WASHINGTON

AT the 235th meeting of the society, held on December 14, 1910, Mr. M. R. Campbell, the retiring president, presented an address, entitled "Historical Review of Theories Advanced by American Geologists Regarding the Origin and Accumulation of Oil."

At the close of Mr. Campbell's address the eighteenth annual meeting of the society was held for the purpose of electing officers, and the following officers were elected for the ensuing year:

President—Mr. Alfred H. Brooks.

Vice-presidents—T. W. Stanton and David White.

Treasurer—Hoyt S. Gale.

Secretaries—Edson S. Bastin and Robert Anderson.

Members at Large of the Council—W. C. Mendenhall, Wm. C. Alden, F. C. Schrader, F. B. Van Horn, Adolph Knopf.

FRANÇOIS E. MATTHES,
Secretary

THE GEOLOGICAL SOCIETY OF WASHINGTON

THE 236th meeting of the society, held on Wednesday evening, December 21, 1910, in the Cosmos Club, was devoted entirely to a discussion of Mr. E. O. Ulrich's paper entitled "The Influence of Marine Currents on Deposition in Continental Seas," delivered before the society on November 30, 1910.

The discussion was opened by Mr. Bailey Willis, who summed up the propositions from which he wished to dissent as follows: (1) that the epicontinental seas of eastern North America during the Middle Ordovician age were so landlocked that marine currents could not have passed through them with sufficient force to have influenced the deposition of sediments, and could not have kept the bottom clean of sediment in any portion of the area which was submerged; (2) that the Gulf Stream does not go to the bottom of its channel and does not scour the bottom. The first, which was brought forward by Mr. Ulrich, he considered largely theoretical, and founded upon an interpretation of the distribution idea which has not sufficient support in the physical evidence of unconformities that must have been developed by subaerial decay and erosion upon exposed portions.

Mr. Willis recognized that there are areas characteristic of the shores of the Ordovician sea and of the shores of islands in that sea where unconformities may be recognized by the usual evidences of erosion; and also that there are other localities where limestones are wanting that are elsewhere developed to notable thicknesses. In many of these partial sequences there is no evidence of exposure to subaerial agencies. In these cases it is reasonable to consider the alternative proposition of marine scour as of at least equal value in interpretation with that of the former existence of land.

In answer to Mr. Ulrich's statement that the Ordovician seas were landlocked, he pointed out the evidence brought forward by paleontologists for the wide distribution of faunas composed of numerous species, and maintained that marine currents were the most effective agencies in promoting that distribution. Were the seas so land-

locked as Mr. Ulrich supposed, the food supply would fail and the condition which has been reached by the present Black Sea whose waters are incapable of supporting life that in any way approaches that of the Ordovician, might be reached.

Referring to the paleogeographic maps which have been issued by Dr. Schuchert and to Mr. Ulrich's views on the details of paleogeography in the Paleozoic age, Mr. Willis held that no one is yet in a position to interpret the evidence for limited intervals of time. The study requires the most searching investigation of the different lines of evidence and a better understanding of the principles that shall govern the interpretation before any more than general outlines of the geography can be mapped. Dr. Schuchert's maps represent the distribution of faunas, and for each fauna which is mapped they represent the extent of the temperature, food and other conditions that determined its habitat. In this respect they are of the highest value. Where, however, the absence of a fauna or a formation has been taken as a proof of the existence of land without evidence of erosion, the maps are misleading, since the alternative hypothesis that the area was submerged, but was inhospitable to that particular fauna, has not received due consideration. The causes which now maintain the great equatorial currents flowing from east to west have been in operation since the oceans were established. Currents and eddies diverted from these main currents by the continental platforms have necessarily been features of all continental seas, and no study of the life conditions of extinct faunas can be adequate that does not take account of the biological and physical effects of such currents. Hence any inference based upon faunas which are interpreted without reference to currents must be fallacious.

In regard to the subject of marine scour, especially by the Gulf Stream, Mr. Willis presented a map showing the submarine deposits of the Caribbean, Gulf and North Atlantic, as given by Agassiz in the "Three Cruises of the *Blake*." That map shows that sediment is deposited under the axis of the Gulf Stream between Cuba and Florida along much of the coast, for the depth of the water is there greater than the depth of the current, which does not reach much below 100 or 150 fathoms, but where the water is shallower or where the current turns from its easterly to a northerly course, it is carried against the bottom and at those points there is a hard limestone bottom covered only by fragments of broken rock and coral, and washed clean by the current. It also appeared from Agassiz's discussion of the action of the dredge that the areas which he mapped as limestone plateaus have a hard and uneven rock bottom, and although the Coast Survey charts over much of the areas so mapped by him show soundings of sand and broken shell, the evidence is that the material brought up on the sounding line is but a superficial coating, locally covering the uneven limestone bottom. Admiral Pillsbury has shown that the volume of water passing a section of the Florida Straits in one hour amounts to nearly 90 billion tons. It has a velocity which varies from two to three and one half knots. The energy of this mass of water could not be lightly checked. Should the sea bottom between Florida and Cuba be gently elevated by an orogenic movement, or should the general level of the ocean be lowered so that the current would reach the bottom, the silt which is now deposited beneath the current would inevitably be swept away. A barrier to the current would only be established in case the orogenic movement raised the bottom more actively than the current could erode it. This could scarcely occur unless the bottom were hard rock. The condition which is thus suggested is that which may be considered as a working hypothesis in explanation of the imbricated limestone of the Ordovician in the eastern United States. It is postulated that there was an extensive sea which was open from south to north, and through which marine currents circulated, as is indicated by the distribution of life. The sea deepened or shallowed from time to time, and there were basins which, according to the great thickness of sediments laid down in them, deepened, while other areas apparently remained as saddles between them. If this interpretation of the physical and faunal facts be correct, it is reasonable to suppose that the currents were at times brought within reach of the bottom and that a condition of non-deposition supervened locally during a more or less prolonged interval.

The discussion was continued by Rear Admiral J. E. Pillsbury, who had command of the Coast Survey steamer *Blake* for five years and spent a large portion of each year investigating the Gulf Stream. He first explained the methods formerly used of gauging marine currents by cans floating on the surface and submerged below, and then the methods adopted by the *Blake* of anchoring the vessel in the stream and measuring the

velocity and direction of the flow on the surface and at various depths by means of a current meter. Many hundreds of observations were taken in the straits of Florida between Fowey Rocks and the Bahamas, between Havana and the Florida reefs, in the Straits of Yucatan, in the Equatorial Current between Tobago and Barbadoes, in all the passages between the West Indian Islands and off Cape Hatteras.

The section off Fowey Rocks was studied during two winter seasons and at other times for brief periods. This is the narrowest part of the Straits of Florida, being about 42 miles in width. On the west side the bottom descends with fairly regular slope to 400 fathoms, at 15 miles distant, while on the east side 400 fathoms is found at but eight miles from the shore. Anchorages were made at approximately seven-mile intervals across the straits. The bottom was found to be branch coral and broken shells at the anchorage nearest the Bahamas, and there was every evidence from the observations that the current reached the bottom here. The stream off Havana flows east, while off Fowey Rocks it has changed its direction 80°, and the inertia of the water in making the turn forces the current to impinge upon the confining bank and carries it to the bottom. Between this point and the western slope the observations showed an average current only to about 300 fathoms depth, while on the western slope itself the current sometimes reached the bottom and sometimes a negative current was observed. At all anchorages except the easternmost, mud was brought up by dredge and frequently on the anchor. At eleven and one half miles east of Fowey Rocks there is an outcropping of rock on which an anchor fouled three times, making it necessary to cut the anchoring rope to get underway, but at other places the bottom was soft. On both sides of the straits the current at times was found to be flowing north as far out as a depth of 10 fathoms or even further off shore.

It has been stated that the presence of gulf seaweeds near Nantucket shows the Gulf Stream to be flowing there. The Gulf Stream is partly caused by the friction of the trade-winds on the surface of the ocean, and partly by the break of the wave which throws a certain amount of water from its crest into the trough. As the trades are persistent, this becomes a simultaneous movement of the whole surface of the sea within trade-wind limits. Gulf seaweed floats with the current, but it is thrown to leeward by the waves faster than any ordinary current can carry it, or when there is no current at all. The water on the Florida reefs about Key West are of milky appearance, while a northerly breeze is blowing which stirs up the bottom coral mud. A southerly breeze brings in the clear water of the Gulf Stream simply by the break of the waves, but no current accompanies it.

The Grenadine Bank extends from Grenada to the Island of St. Vincent and is in the direct line of flow of the trade wind current outside the Caribbean. An anchorage in 17 fathoms near its outside edge showed no current crossing the bank, but the break of the waves was all the time carrying water into the Caribbean across the shoal.

As the discussion was extended to a consideration of the general effects of oceanic currents on deposition, Mr. T. Wayland Vaughan called attention to the investigations Rear Admiral Sir W. J. L. Wharton[1] made around the islands of the Ellice Group and on submarine banks in that region. According to this authority, fine mud and sand may be moved to a depth of 80 fathoms, and there is evidence of the chafing of cables to a depth of 260 fathoms; "volcanic ash can be moved at depths of 30 fathoms or more when exposed to the action of waves in an otherwise deep sea over which strong winds are continually blowing."

Professor J. Stanley Gardiner[2] has described the submarine platform on which the Maldive and Laccadive archipelagoes stand, and has called attention to the generally hard bottom on it. This platform occupies a level about 200 fathoms below sea level, and he says, "there is little doubt but that it is surrounded with precipitous walls or a steep slope for an additional 600 fathoms at least." Professor Gardiner is of the opinion that this platform was formed by marine erosion to the depth of 200 fathoms below sea level. He states, "there is little doubt but that currents may extend to considerable depth and sweep the ocean floor quite bare. Indeed, wherever in the ocean a rocky bottom is found, its character is probably due to an ocean current."

Dr. Paul Bartsch discussed the distribution of the recent marine mollusks with a view to throwing some light upon past conditions. He presented a map showing the extent of the existing faunal areas and called special attention to the

[1] *Nature*, LV., 1897, "Foundations of Coral Atolls."

[2] "The Fauna and Geography of the Maldive and Laccadive Archipelagoes," Vol. 1, Pt. 2, pp. 172, 173.

fact that these areas are coextensive with the existing ocean currents.

He gave some tables, based upon the West American Pyramidellidæ, showing that in this group a remarkably small percentage of the species extended over more than one area. He stated that he considered ocean currents an important factor in the distribution of marine organisms, since they determined practically all the factors entering into the environment in each area, viz., temperature, food, salinity and transportation of larval forms.

Mr. Ulrich, replying to Mr. Willis's discussion, said that most of Mr. Willis's objections had been anticipated and accounted for in the paper read at the previous meeting. It was denied that this paper contained any statement indicating that its author is inclined to the belief that marine currents in the Ordovician epicontinental seas of North America were *never* capable of effecting the deposition of sediments or of keeping the "bottom clean of sediment in any portion of the submerged seas." On the contrary, Mr. Ulrich mentioned a number of instances of locally interrupted deposition attributable to current scour but claimed that these were quite distinct in their causation from the wider discontinuities which have been similarly interpreted by Mr. Willis. It was further denied that the paper sought in any wise to discredit the effect of currents on the distribution of marine organisms. Also that the deduction of frequently shifting, limited and far from transcontinental seas is founded solely on "an interpretation of the distribution of faunas which disregards all the limiting conditions of marine environment except land barriers." Mr. Ulrich insisted that before reaching his conclusions he had considered more or less fully all physical as well as the purely faunal criteria that seemed to have any direct bearing on the problem. Considering that Mr. Willis has paid perhaps as little attention to detailed field investigation of stratigraphic unconformities as to the study of recent or fossil zoology, his short dismissal of conclusions based largely upon such studies as "purely theoretical" seems rather unscientific. His remark respecting detailed paleogeographic mapping, when he said "that no one is yet in a position to interpret the evidence for limited intervals of time" is similarly unjust.

Mr. Willis's statement that the Ordovician seas, "if so land-locked as Mr. Ulrich supposed," would have become, like the Black Sea, "incapable of supporting life that in any way approaches that of the Ordovician," was based upon a misconception of Mr. Ulrich's meaning. As conceived by Mr. Ulrich, Ordovician continental seas invaded the land areas from one or another of the permanent oceanic basins; with which they maintained their connection and from which they derived their faunas throughout their existence.

Evidence of erosion is nearly always to be found wherever a considerable hiatus in the stratigraphic sequence is indicated by the fossils. In view of the fact that such breaks in the stratigraphic sequence commonly extend over by far the greater part of the median area of the continent, it is impossible to account for the wide absence of the deposits and faunas by virtue of any reasonably conceivable current efficiency. Nor can any other interpretation save emergence be advanced to explain the established geographic limitations of the Paleozoic faunas, especially when no fauna of nearly similar age is found in adjacent areas.

The distribution of many types of littoral and bottom-dwelling organisms takes place largely in disregard of marine currents. There are other types, however, notably the plankton and especially reef corals and sessile bryozoa, which propagate by means of free-swimming larvæ, that throw much light on the direction and extent of the currents in the Paleozoic continental seas. In every case where the distribution of the latter has been studied it is found that they rapidly become fewer away from the point of invasion of the particular sea in which they lived. In most instances they disappear entirely before reaching the inner shores of the sea whose extent is determined by continuity of deposits and the presence of other organisms less dependent on currents for their migration. This perfectly competent evidence, therefore, is invariably opposed to Mr. Willis's theory of great inland seas and of transcontinental currents which if present might have been important factors in accounting for stratigraphic hiatuses.

Dr. R. S. Bassler called attention to the fact that the trend of the discussion was losing sight of the stratigraphic side of the question. These distinct northern and southern faunas occurred in distinct formations overlapping to extinction either to the south or north as the case might be. He added that these facts must be explained before currents can be held accountable for the great faunal differences.

Edson S. Bastin,
Secretary